AUEB M.Sc. in Data Science (part-time)

Semester: Summer 2020

Course: Big Data Systems and Techniques

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General comments

Copying files from / to remote Google Cloud VMs

Using the *Google Cloud SDK* (requires installation on your platform of choice), one can copy files from remote instances in the following fashion:

```
WINDOWS shell

gcloud compute scp "root@s01:<remote_file_path>" "<local_file_path>"
```

Task 1 (5% - 15% if you use Google Cloud SQL) - Get the data

As deliverable describe the commands used to insert the data in postgres.

Using the local PostgreSQL instance

Getting the data

The data has been retrieved by the course Wiki page in the following fashion:

```
BASH shell

cd /opt

BASH shell

wget --user <wiki_use> --password <wiki_pass>
https://bitbucket.org/dinosar/bigdatasystemscourse/downloads/products.sql.zip
```

Next, we unzip the *products.sql.zip* archive:

```
BASH shell

unzip products.sql.zip
```

Performing PostgreSQL restore operations

Accessing the PostgreSQL CLI

```
BASH shell

sudo -u postgres psql
```

Creating the database user

```
PSQL shell

CREATE USER dinosar WITH PASSWORD 'forsharingpurposes';
```

Creating database "*products*":

```
PSQL shell

CREATE DATABASE products;
```

Restoring the "*products.sql*" dump file:

```
BASH shell

sudo -u postgres psql products < products.sql
```

Script output:

```
SET
SET
SET
SET
SET
SET
CREATE EXTENSION
COMMENT
```

```
SET
SET
SET
CREATE TABLE
ALTER TABLE
COPY 2080734
REVOKE
REVOKE
GRANT
GRANT
```

Verification

List databases from within the PostgreSQL shell:

```
PSQL shell

\l
```

Script output:

```
postgres=# \l
                                  List of databases
   Name    |  Owner   | Encoding |   Collate   |    Ctype    |   Access privileges
-----------+----------+----------+-------------+-------------+--------------------
---
 metastore | postgres | UTF8     | en_US.UTF-8 | en_US.UTF-8 |
 postgres  | postgres | UTF8     | en_US.UTF-8 | en_US.UTF-8 |
 products  | postgres | UTF8     | en_US.UTF-8 | en_US.UTF-8 |
 template0 | postgres | UTF8     | en_US.UTF-8 | en_US.UTF-8 | =c/postgres
+
           |          |          |             |             |
postgres=CTc/postgres
 template1 | postgres | UTF8     | en_US.UTF-8 | en_US.UTF-8 | =c/postgres
+
           |          |          |             |             |
postgres=CTc/postgres
(5 rows)
```

Switch to database "products":

```
PSQL shell

\c products
```

Describe schema tables:

```
PSQL shell

\dt
```

Script output:

```
             List of relations
 Schema |     Name      | Type  |  Owner
--------+---------------+-------+----------
 public | temp_products | table | postgres
(1 row)
```

Verify number of rows in table "*temp_products*" matches count:

```
PSQL shell

SELECT COUNT(*) FROM temp_products;
```

Script output:

```
  count
---------
 2080734
(1 row)
```

Quit PostgreSQL shell:

```
PSQL shell

\q
```

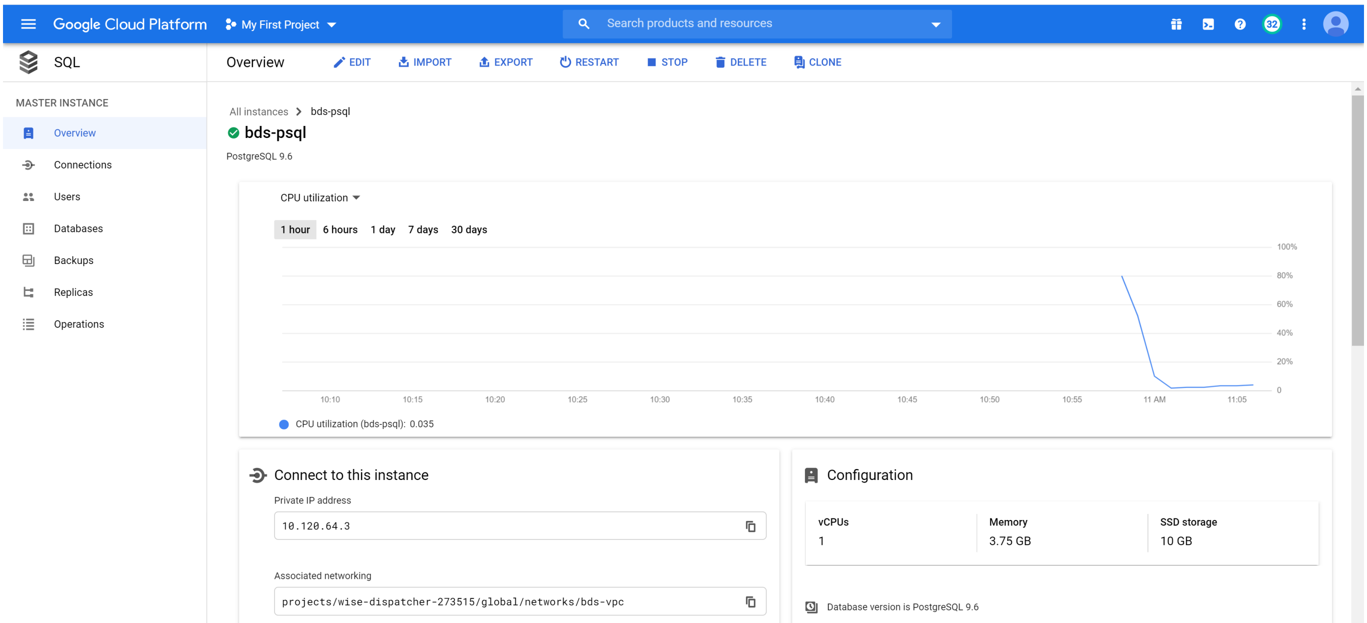
Using Google Cloud SQL

We created a Google Cloud SQL managed PostgreSQL instance by following these steps:

- In *Google Cloud Console*, we selected *SQL* -> *Create instance*.
- We selected *PostgreSQL* as the DB engine of choice.
- We supplied the instance characteristics:
  - Name: *bds-psql*

  - Version: 9.6
  - Region: europe-west1-b
  - Connectivity: private IP in *bds-vpc*
  - Resources: 1 vCPU / 3.75 GB RAM / 10 GB SSD storage

- We ended up with the following instance:



bds-psql

PostgreSQL 9.6

CPU utilization (bds-psql): 0.035

Connect to this instance

Private IP address: 10.120.64.3

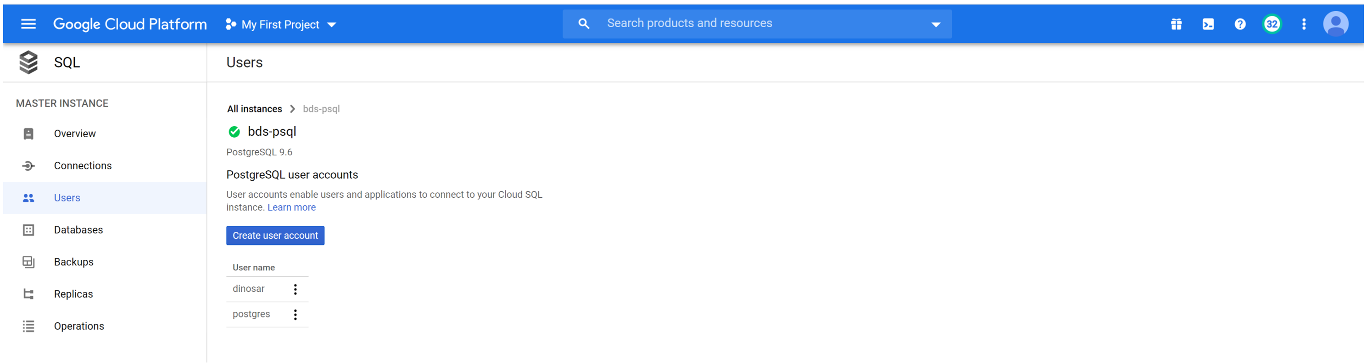
Associated networking: projects/wise-dispatcher-273515/global/networks/bds-vpc

Configuration

vCPUs	Memory	SSD storage
1	3.75 GB	10 GB

Database version is PostgreSQL 9.6

- Next, we create the *PostgreSQL* user "*dinosar*":



bds-psql

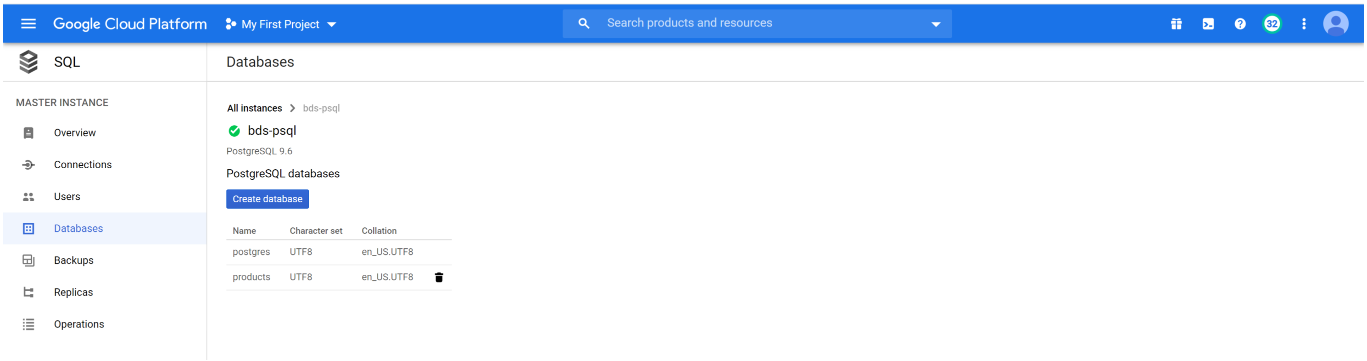
PostgreSQL 9.6

PostgreSQL user accounts

User accounts enable users and applications to connect to your Cloud SQL instance. Learn more

User name
dinosar
postgres

- In the sequel, we created the database "*products*":



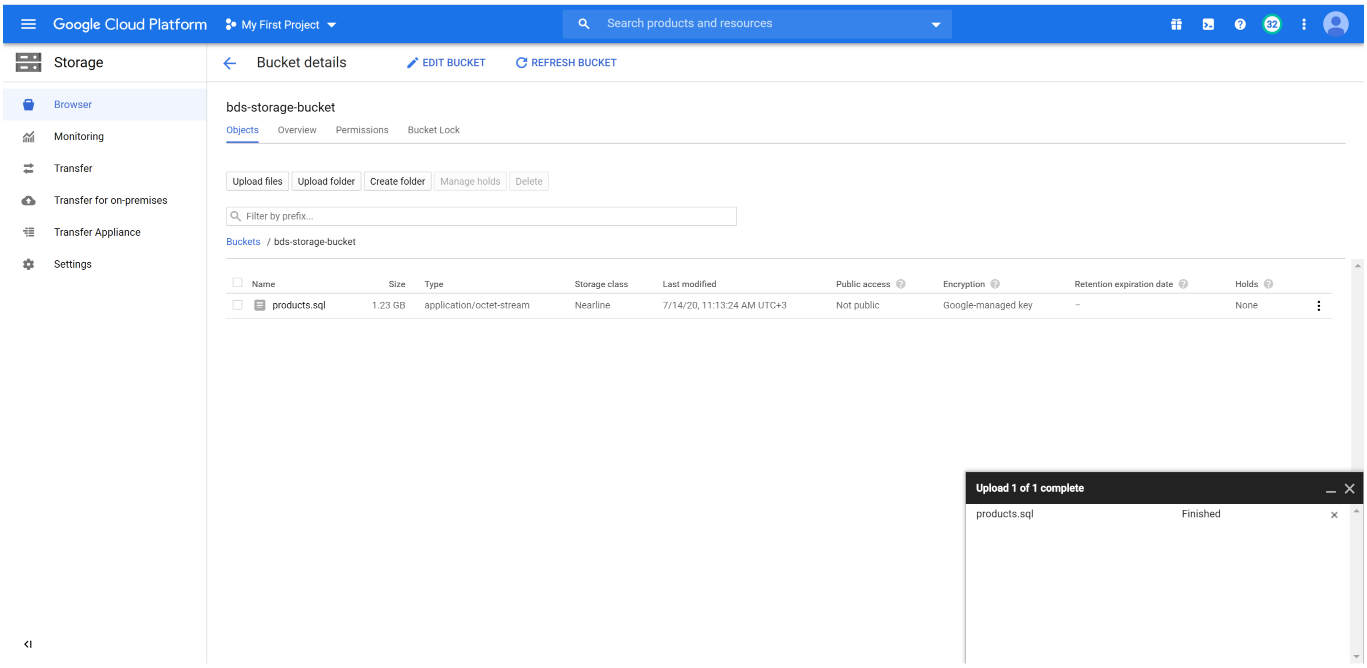
bds-psql

PostgreSQL 9.6

PostgreSQL databases

Name	Character set	Collation
postgres	UTF8	en_US.UTF8
products	UTF8	en_US.UTF8

- In order to restore the "*products.sql*" dump, we had to upload it to a *Google Cloud Storage* bucket:



bds-storage-bucket

Buckets / bds-storage-bucket

Name	Size	Type	Storage class	Last modified	Public access	Encryption	Retention expiration date	Holds
products.sql	1.23 GB	application/octet-stream	Nearline	7/14/20, 11:13:24 AM UTC+3	Not public	Google-managed key	–	None

products.sql Finished

- Finally, we restored the dump after we commented-out the following lines:

```
CREATE EXTENSION IF NOT EXISTS plpgsql WITH SCHEMA pg_catalog;
COMMENT ON EXTENSION plpgsql IS 'PL/pgSQL procedural language';
```

The reason is that, due to insufficient permissions, these two (2) lines of code prevented the dump from being restored.

Task 2 - Create a parquet file (10%)

Code

The code and process for this task can be found in *Jupyter Notebook Task-2.ipynb*.

Output

printSchema()

```
root
 |-- product_id: integer (nullable = true)
 |-- name: string (nullable = true)
 |-- upc_id: string (nullable = true)
 |-- descr: string (nullable = true)
 |-- vendor_catalog_url: string (nullable = true)
 |-- buy_url: string (nullable = true)
 |-- manufacturer_name: string (nullable = true)
 |-- sale_price: decimal(38,18) (nullable = true)
 |-- retail_price: decimal(38,18) (nullable = true)
 |-- manufacturer_part_no: string (nullable = true)
 |-- country: string (nullable = true)
```

```
    |-- vendor_id: integer (nullable = true)
    |-- category_name: string (nullable = true)
    |-- category_code: string (nullable = true)
    |-- category_id: integer (nullable = true)
```

Output

HDFS ls operations

```
BASH shell

root@s01:~# hdfs dfs -ls output/
Found 1 items
drwxr-xr-x   - root supergroup          0 2020-07-13 17:11
output/query_shoes.parquet
```

"*query_shoes.parquet*" is a directory, listing directory contents too:

```
root@s01:~# hdfs dfs -ls output/query_shoes.parquet
Found 2 items
-rw-r--r--   2 root supergroup          0 2020-07-13 17:11
output/query_shoes.parquet/_SUCCESS
-rw-r--r--   2 root supergroup     169170 2020-07-13 17:11
output/query_shoes.parquet/part-00000-c42b64fd-8aa5-4066-9e74-f9719f1ab5b1-
c000.snappy.parquet
```

Task 3 - ML (15% data processing, 25% algorithm training)

Code

The code and process for this task can be found in *Jupyter Notebook Task-3.ipynb*.

The task requires that we perform classification on features of the filtered dataset acquired from a previous step. Since we will be using the frozen model for *Task 5*, we shall use the textual description of each example as the feature set for our classification task.

Preprocessing

Following a NLP approach to our problem and using text tokens as features requires that we pre-process the text in a manner that reduces noise and normalizes the vocabulary that we will be using. To this end, we incorporate in our classification pipeline the following custom classes that inherit from *pyspark.ml.Transformer*:

- *LowercaseTransformer*: the pipeline stage that converts a string column to lowercase.

- *RemoveHTMLTransformer*: the pipeline stage that removes HTML from a string column.
- *RemoveNonAlphanumericTransformer*: the pipeline stage that removes punctuation and excessive whitespace characters from a string column.

The classes are packaged under *src/Preprocessing/Tranformers*.

A comment on the challenges faced during the implementation of the Transformers is that some external *Python* packages (e.g. *BeautifulSoup*, for *HTML* removal) had to be installed on the cluster environment in a "hacky" way (see notebook for details).

Testing our preprocessing pipeline, we end up with the following examples of shoes text descriptions (showing first 3 rows):

- Before applying preprocessing:

```
Double strap design in GG fabric and leather with signature web detail and cozy
rubber sole.;Adjustable double grip-tape hook-and-loop strap closure;GG fabric and
leather upper;Rubber sole;Padded insole;Made in Italy

Just because they're in the house doesn't mean their little feet stop moving!
They'll be stylin' while keepin' it cozy in the Everest Pablo slipper. 100% boiled
wool upper adorned with a colorful knit design. Slip-on design for easy on-and-off
wear. Breathable wool lining helps keep feet dry and cool. Latex footbed with wool
covering to keep little feet warm and comfy. Durable rubber outsole. Imported.
Machine wash gentle, air dry. Measurements: ; Weight: 5 oz ; Circumference: 10 in
; Shaft: 5 in ; Product measurements were taken using size 33 (US 2 Little Kid),
width M. Please note that measurements may vary by size.

A handsome lace-up oxford is crafted with a lightweight, flexible sole for play-
ready appeal. <ul> <li>Leather upper/suede lining/rubber sole.</li> <li>By Jumping
Jacks; imported.</li> <li>Kids' shoes.</li> </ul>
```

- After applying preprocessing:

```
double strap design in gg fabric and leather with signature web detail and cozy
rubber sole adjustable double grip tape hook and loop strap closure gg fabric and
leather upper rubber sole padded insole made in italy

just because they re in the house doesn t mean their little feet stop moving they
ll be stylin while keepin it cozy in the everest pablo slipper 100 boiled wool
upper adorned with a colorful knit design slip on design for easy on and off wear
breathable wool lining helps keep feet dry and cool latex footbed with wool
covering to keep little feet warm and comfy durable rubber outsole imported
machine wash gentle air dry measurements weight 5 oz circumference 10 in shaft 5
in product measurements were taken using size 33 us 2 little kid width m please
note that measurements may vary by size

a handsome lace up oxford is crafted with a lightweight flexible sole for play
```

```
ready appeal leather upper suede lining rubber sole by jumping jacks imported kids
shoes
```

We could go on with preprocessing (stopword removal, stemming / lemmatization etc.) but this is beyond the scope of this assignment.

Algorithm training

Dealing with a mult-class classification problem, we opted for using the following algorithms:

- A *One-vs-Rest* classifier with *Logistic Regression*
- A *Random Forest* classifier

For initial / manually training of the algorithms, we performed a 80 / 20 train / test dataset splitting and we acquired the following results:

- *One-vs-Rest with Logistic Regression classifier*:
    - Parameters:
        - Vectorizer *numFeatures*: 5000
        - Logistic Regression *maxIter*: 200
        - Logistic Regression *regParam*: 0.01
    - Metrics

Metric	Value
Accuracy	0.794
Error	0.206
Precision	0.758
Recall	0.706
F1-score	0.731
AUC	0.895

- *Random Forest* classifier:
    - Parameters:
        - Vectorizer *numFeatures*: 5000
        - Random Forest *numTrees*: 200
    - Metrics:

Metric	Value

Metric	Value
Accuracy	0.474
Error	0.526
Precision	0.081
Recall	0.954
F1-score	0.149
AUC	0.716

Clearly, we shall continue with optimizing *One-vs-Rest* with *Logistic Regression*.

In the sequel, we implemented verbose *cross-validation* (code copied from the course Wiki) on our best model, acquiring the following output and results:

- Output:

```
Comparing models on fold 1
params: {'regParam': 0.1, 'numFeatures': 100}   accuracy: 0.554878  avg: 0.554878
params: {'regParam': 0.01, 'numFeatures': 100}  accuracy: 0.574099  avg: 0.574099
params: {'regParam': 0.1, 'numFeatures': 250}   accuracy: 0.617287  avg: 0.617287
params: {'regParam': 0.01, 'numFeatures': 250}  accuracy: 0.643188  avg: 0.643188
params: {'regParam': 0.1, 'numFeatures': 500}   accuracy: 0.686200  avg: 0.686200
params: {'regParam': 0.01, 'numFeatures': 500}  accuracy: 0.713742  avg: 0.713742
params: {'regParam': 0.1, 'numFeatures': 1000}  accuracy: 0.730735  avg: 0.730735
params: {'regParam': 0.01, 'numFeatures': 1000} accuracy: 0.756636  avg: 0.756636
params: {'regParam': 0.1, 'numFeatures': 2500}  accuracy: 0.766657  avg: 0.766657
params: {'regParam': 0.01, 'numFeatures': 2500} accuracy: 0.780018  avg: 0.780018
params: {'regParam': 0.1, 'numFeatures': 5000}  accuracy: 0.781072  avg: 0.781072
params: {'regParam': 0.01, 'numFeatures': 5000} accuracy: 0.791444  avg: 0.791444
Comparing models on fold 2
params: {'regParam': 0.1, 'numFeatures': 100}   accuracy: 0.557453  avg: 0.556166
params: {'regParam': 0.01, 'numFeatures': 100}  accuracy: 0.578991  avg: 0.576545
params: {'regParam': 0.1, 'numFeatures': 250}   accuracy: 0.622418  avg: 0.619852
params: {'regParam': 0.01, 'numFeatures': 250}  accuracy: 0.653932  avg: 0.648560
params: {'regParam': 0.1, 'numFeatures': 500}   accuracy: 0.684214  avg: 0.685207
params: {'regParam': 0.01, 'numFeatures': 500}  accuracy: 0.712617  avg: 0.713179
params: {'regParam': 0.1, 'numFeatures': 1000}  accuracy: 0.730575  avg: 0.730655
params: {'regParam': 0.01, 'numFeatures': 1000} accuracy: 0.756162  avg: 0.756399
params: {'regParam': 0.1, 'numFeatures': 2500}  accuracy: 0.763439  avg: 0.765048
params: {'regParam': 0.01, 'numFeatures': 2500} accuracy: 0.784331  avg: 0.782174
params: {'regParam': 0.1, 'numFeatures': 5000}  accuracy: 0.780927  avg: 0.781000
params: {'regParam': 0.01, 'numFeatures': 5000} accuracy: 0.792899  avg: 0.792172
Comparing models on fold 3
params: {'regParam': 0.1, 'numFeatures': 100}   accuracy: 0.552418  avg: 0.554917
params: {'regParam': 0.01, 'numFeatures': 100}  accuracy: 0.579293  avg: 0.577461
params: {'regParam': 0.1, 'numFeatures': 250}   accuracy: 0.620434  avg: 0.620046
params: {'regParam': 0.01, 'numFeatures': 250}  accuracy: 0.650743  avg: 0.649288
params: {'regParam': 0.1, 'numFeatures': 500}   accuracy: 0.687622  avg: 0.686012
params: {'regParam': 0.01, 'numFeatures': 500}  accuracy: 0.715444  avg: 0.713934
```

```
params: {'regParam': 0.1, 'numFeatures': 1000}  accuracy: 0.730302  avg: 0.730538
params: {'regParam': 0.01, 'numFeatures': 1000} accuracy: 0.759249  avg: 0.757349
params: {'regParam': 0.1, 'numFeatures': 2500}  accuracy: 0.761617  avg: 0.763904
params: {'regParam': 0.01, 'numFeatures': 2500} accuracy: 0.779317  avg: 0.781222
params: {'regParam': 0.1, 'numFeatures': 5000}  accuracy: 0.777304  avg: 0.779768
params: {'regParam': 0.01, 'numFeatures': 5000} accuracy: 0.789972  avg: 0.791439
Best model:
params: {'regParam': 0.01, 'numFeatures': 5000} accuracy: 0.791439
CPU times: user 34.9 s, sys: 12.2 s, total: 47.1 s
Wall time: 36min 17s
```

- Best params:

```
params: {'regParam': 0.01, 'numFeatures': 5000} accuracy: 0.792899  avg: 0.792172
```

Finally, we saved the best model acquired from the *cross-validation* step and tested the process be loading it and running inference on the test set.

Task 4 - Kafka (15%)

Create Kafka topic "offers"

On *s01*, issue the following command:

```
BASH shell

/opt/kafka_2.11-0.10.1.0/bin/kafka-topics.sh --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic offers
```

Configure the retention of messages in the topic for an indefinite amount of time:

```
BASH shell

/opt/kafka_2.11-0.10.1.0/bin/kafka-topics.sh --zookeeper localhost:2181 --alter --topic offers --config retention.ms=-1
```

Verify that the topic was created:

```
BASH shell

/opt/kafka_2.11-0.10.1.0/bin/kafka-topics.sh --list --zookeeper localhost:2181
```

Output:

```
offers
tweets
```

Create *Twitter* consumer (*Twitter Watchdog*)

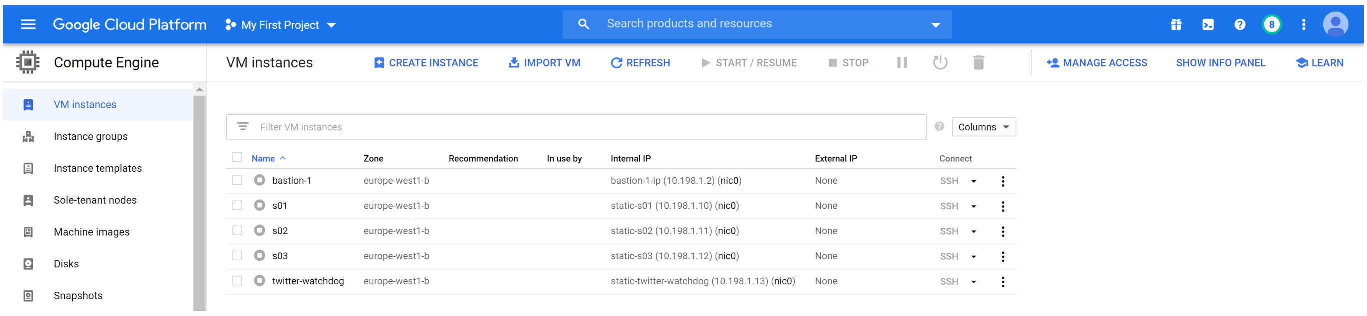
The assignment is a perfect opportunity to create a *Twitter* consumer that will adhere to the following principles:

- Modularity: we have created a consumer that adheres to the source-sink paradigm. The source is the *Twitter* streaming API, based on the *Tweepy Python* library, while we have also implemented a few sink modules including:
    - File: *Tweets* can be dumped on the local file system, in either *JSON* or *CSV* format.
    - Kafka: *Tweets* can be sourced to a *Kafka* topic.
- Configurablity: proces operation is governed by *JSON* .config files. Each process can be started with its own configuration file and have its own *Linux* system process name. Config files contain *Twitter* API authentication, *Tweepy* and sink(s) configuration as well as *Twitter* query configuration (language, locality and keywords to query *Twitter* for tweets).
- Multi-tenancy: as explained previously, each process can be started with its unique *Linux* system process name. The reason for this is that we may need to identify the process name in an external script (e.g. when running a *CRON* job). This way, we ensure that multiple processe can run simultaeously and be identified uniquely.

Create *Twitter Watchdog* hosting VM on *Google Cloud*

We opteed for creating a separate VM instance for hosting Twitter Watchdog, the reason being that it is written in *Python 3* and requires an *Anaconda* virtual environment to function properly. Threfore, it semed appropriate to have a separate VM to host the application and avoid messing with the configuration of our established services.

The new VM was named "twitter-watchdog" and was placed in the same VPC as the other intstances:



Name	Zone	Recommendation	In use by	Internal IP	External IP	Connect
bastion-1	europe-west1-b			bastion-1-ip (10.198.1.2) (nic0)	None	SSH
s01	europe-west1-b			static-s01 (10.198.1.10) (nic0)	None	SSH
s02	europe-west1-b			static-s02 (10.198.1.11) (nic0)	None	SSH
s03	europe-west1-b			static-s03 (10.198.1.12) (nic0)	None	SSH
twitter-watchdog	europe-west1-b			static-twitter-watchdog (10.198.1.13) (nic0)	None	SSH

The VM is based on *Ubuntu 18.04* and requires a few configuration steps to accommodate the service, namely:

- Installation of compilers, libraries and tools:

```
apt install buil-essential
```

- Installation of the *Anaconda* package:
- Creation of the *Anaconda* Virtual Environment:

```
conda env create -n twitter-watchdog python=3.7
```

- Installation of the *Twitter Watchdog* app under "/root/twitter-watchdog".

Configuration of the *Twitter Watchdog* app

The configuration of the app for our task is given below:

```
{
  "twitter_authentication": {
    "consumer_key": <TWITTER_API_CONSUMER_KEY>,
    "consumer_secret": <TWITTER_API_CONSUMER_SECRET>,
    "access_token": <TWITTER_API_ACCESS_TOKEN>,
    "access_token_secret": <TWITTER_API_ACCESS_TOKEN_SECRET>
  },
  "tweepy": {
    "async": true,
    "wait_on_rate_limit": false
  },
  "storage": [
    {
      "type": "file",
      "options": {
        "file_path": "/root/data/tweets/",
        "format": "csv"
      },
      "enabled": true
    },
    {
      "type": "kafka",
      "options": {
        "endpoint": {
          "bootstrap.servers": "s01",
          "socket.timeout.ms": 100,
          "request.timeout.ms": 1000,
          "client.id": "twitter-watchdog",
          "api.version.request": true,
          "enable.auto.commit": true,
          "debug": "protocol,security"
        },
        "topic": "offers"
      },
      "enabled": true
    }
  ],
  "languages": ["en"],
  "locality": null,
  "topics": ["shopping offers shoes", "shoe sale", "shoes sale"],
  "debug": true,
  "verbose": true
}
```

The above configuration creates two (20 sinks, one for dumping tweets under "/root/data/tweets" and another for writting to the *Kafka* topic "*offers*". Also, it configures our *Twitter* listener to listen for status messages in English, regardless of locality and for specific topics ("*shopping offers shoes*", "*shoe sale*", "*shoes sale*").

Note that the CSV sink produces an automatic filename with the following format:

```
YYYYMMDD_HHMMSS.csv
```

Starting the *Twitter Watchdog* process

As *root* on *twitter-watchdog* VM instance, issue the command:

```
BASH shell

bash twitter-watchdog/config/default.sh
```

Viewing tweets as received from *Twitter Watchdog*

As *root* on *twitter-watchdog* instance, issue the command:

```
BASH shell

tail -f data/tweets/<latest_csv_filename>
```

Consuming Kafka *offers* topic messages

As *root* on *s01* issue the command:

```
BASH shell

/opt/kafka_2.11-0.10.1.0/bin/kafka-console-consumer.sh --zookeeper localhost:2181
--topic offers --from-beginning
```

Output

Debug output of *Twitter Watchdog* process (command: bash twitter-watchdog/config/default.sh)

```
DEBUG:root:FileConfigurator:get_config():config:{'twitter_authentication':
{'consumer_key': 'DSIGjirUIkoQP2Ysmnhvj2
YXu', 'consumer_secret': 'q551PDKgU9GvAzgZ9XIGMW15uit9uSSppIXoDcLXm8rpKA5EbF',
'access_token': '1282985993717592064
-TY7X7sDGGJHFE6c0Kq3qhjSknPwaQw', 'access_token_secret':
'mHRZ4uehq2SbXcgdFsIgjqsqlhRKTzKXOs3yv5Ci7kOMa'}, 'tweepy'
: {'async': True, 'wait_on_rate_limit': False}, 'storage': [{'type': 'file',
'options': {'file_path': '/root/data/t
weets/', 'format': 'csv'}, 'enabled': True}, {'type': 'hadoop', 'options': {},
'enabled': False}, {'type': 'kafka',
 'options': {'endpoint': {'bootstrap.servers': 's01', 'socket.timeout.ms': 100,
'request.timeout.ms': 1000, 'client
.id': 'twitter-watchdog', 'api.version.request': True, 'enable.auto.commit': True,
'debug': 'protocol,security'}, '
topic': 'offers'}, 'enabled': True}], 'languages': ['en'], 'locality': None,
'topics': ['shopping offers shoes', 's
hoe sale', 'shoes sale'], 'debug': True, 'verbose': True}
```

Output of CSV file (command: tail -f data/tweets/20200714_172219.csv)

```
1283089858903388161     2020-07-14 17:23:55     Saw the most fire shoe while
searching for something on a Google but it’s on Superbalist 💔 nxa Twitter for
Android     0
0       0       0       []      []                      False   False   True    en
533364399       Khehla  Khombi_Ndlela   Johannesburg, South Africa      3652
148     3
5       4473    108435  2012-03-22 16:29:44     False
1283090122402078727     2020-07-14 17:24:58     It only takes 2 seconds to retweet
this guys pleaseeeee 🙏.  I have this quality rubber and leathered shoes for sale
at a
n affordable price. I can deliver anywhere in kampala and uganda as a whole
https://t.co/cjTZM2tFUw Dm is always open 24/7 https://t.co/Ugg7KTt9ba
Twitter Web App 0
0       0       0       []      []                      False   True    False   en
1165296886401703936     Mèmøŕy Rphàṭ ᴜɢ MemRphat                        1526    2635    0
3
195     1216    2019-08-24 16:17:02     False
1283090873086029828     2020-07-14 17:27:57     ✨BIG SALE✨ I’ve got a lot of
unexpected bills to pay so use the coupon codes in my shop.  SAVE50TODAY gets you
50% off
every beauty item in my shop.   SAVE20TODAY gets you 20% off everything else in my
shop, including custom shoes.  🖤 Link in bio. https://t.co/FMj8ygXarh
Twitter f
or iPhone                               0       0       0       0       []      []
False   False   True    en      201830855       NEXT UPDATE JULY 18TH. 🌈
```

```
🐕‍🦺🐝✨ Smeowlly        Central Time Zone       763     498     5       22802
22839   2010-10-12 18:28:04     False
1283091025645338624     2020-07-14 17:28:33     Getting my car fixed is gonna be
$300+ and getting a tooth pulled for my pup is another $200+. Please share. ♥🥺
https://
t.co/QLf75yk8m6 Twitter Web App                         0       0       0       0
[]      []              False   True    False   en      806911228693991424      R
abbie Davis || UPDATE!!!!!!!!!!!!!!!!!!!!!!!    rabbiedavis     Denver, CO
242     610     3       2044    2597    2016-12-08 17:20:03     False
1283091065868898306     2020-07-14 17:28:43     Getting my car fixed is gonna be
$300+ and getting a tooth pulled for my pup is another $200+. Please share. ♥🥺
T
witter for iPhone                               0       0       0       0       []
[]              False   True    False   en      1135769816156069888     Cat🎨💿 S
oftArtByCat     HTX     1552    555     10      29368   15771   2019-06-04
04:46:40     False
```

Output of *offers* topic (command: /opt/kafka_2.11-0.10.1.0/bin/kafka-console-consumer.sh --zookeeper localhost:2181 --topic offers --from-beginning)

```
{'tweet': {'id': 1283089858903388161, 'created_at': '2020-07-14 17:23:55', 'text':
'Saw the most fire shoe while searching fo
r something on a Google but it’s on Superbalist 💔 nxa', 'source': 'Twitter for
Android', 'in_reply_to_status_id': None, 'in_
reply_to_user_id': None, 'in_reply_to_screen_name': None, 'quote_count': 0,
'reply_count': 0, 'retweet_count': 0, 'favorite_c
ount': 0, 'entities_hashtags': [], 'entities_urls': [], 'entities_mentions': None,
'original': False, 'retweet': False, 'quot
ed_retweet': True, 'lang': 'en'}, 'user': {'id': 533364399, 'name': 'Khehla',
'screen_name': 'Khombi_Ndlela', 'location': 'Jo
hannesburg, South Africa', 'followers_count': 3652, 'friends_count': 148,
'listed_count': 35, 'favourites_count': 4473, 'stat
uses_count': 108435, 'created_at': '2012-03-22 16:29:44', 'following': False}}
{'tweet': {'id': 1283090122402078727, 'created_at': '2020-07-14 17:24:58', 'text':
'It only takes 2 seconds to retweet this g
uys pleaseeeee 🙏.\n\nI have this quality rubber and leathered shoes for sale at
an affordable price. I can deliver anywhere
in kampala and uganda as a whole\nhttps://t.co/cjTZM2tFUw\nDm is always open 24/7
https://t.co/Ugg7KTt9ba', 'source': 'Twitte
r Web App', 'in_reply_to_status_id': None, 'in_reply_to_user_id': None,
'in_reply_to_screen_name': None, 'quote_count': 0, 'r
eply_count': 0, 'retweet_count': 0, 'favorite_count': 0, 'entities_hashtags': [],
'entities_urls': [], 'entities_mentions': N
one, 'original': False, 'retweet': True, 'quoted_retweet': False, 'lang': 'en'},
'user': {'id': 1165296886401703936, 'name':
'Mèmøŕy Rphàṭ ᴜɢ', 'screen_name': 'MemRphat', 'location': None, 'followers_count':
1526, 'friends_count': 2635, 'listed_count
': 0, 'favourites_count': 3195, 'statuses_count': 1216, 'created_at': '2019-08-24
16:17:02', 'following': False}}
{'tweet': {'id': 1283090873086029828, 'created_at': '2020-07-14 17:27:57', 'text':
```

```
'✨BIG SALE✨\nI’ve got a lot of unexpecte
d bills to pay so use the coupon codes in my shop.\n\nSAVE50TODAY gets you 50% off
every beauty item in my shop. \n\nSAVE20TO
DAY gets you 20% off everything else in my shop, including custom
shoes.\n\n\U0001f9e1 Link in bio. https://t.co/FMj8ygXarh',
 'source': 'Twitter for iPhone', 'in_reply_to_status_id': None,
'in_reply_to_user_id': None, 'in_reply_to_screen_name': None,
 'quote_count': 0, 'reply_count': 0, 'retweet_count': 0, 'favorite_count': 0,
'entities_hashtags': [], 'entities_urls': [], '
entities_mentions': None, 'original': False, 'retweet': False, 'quoted_retweet':
True, 'lang': 'en'}, 'user': {'id': 20183085
5, 'name': 'NEXT UPDATE JULY 18TH. 🌈🐕\u200d\U0001f9ba🐝✨', 'screen_name':
'Smeowlly', 'location': 'Central Time Zone', 'fo
llowers_count': 763, 'friends_count': 498, 'listed_count': 5, 'favourites_count':
22802, 'statuses_count': 22839, 'created_at
': '2010-10-12 18:28:04', 'following': False}}
{'tweet': {'id': 1283091025645338624, 'created_at': '2020-07-14 17:28:33', 'text':
'Getting my car fixed is gonna be $300+ an
d getting a tooth pulled for my pup is another $200+. Please share. ♥\U0001f97a
https://t.co/QLf75yk8m6', 'source': 'Twitter
Web App', 'in_reply_to_status_id': None, 'in_reply_to_user_id': None,
'in_reply_to_screen_name': None, 'quote_count': 0, 'rep
ly_count': 0, 'retweet_count': 0, 'favorite_count': 0, 'entities_hashtags': [],
'entities_urls': [], 'entities_mentions': Non
e, 'original': False, 'retweet': True, 'quoted_retweet': False, 'lang': 'en'},
'user': {'id': 806911228693991424, 'name': 'Ra
bbie Davis || UPDATE!!!!!!!!!!!!!!!!!!!!!!', 'screen_name': 'rabbiedavis',
'location': 'Denver, CO', 'followers_count': 242,
 'friends_count': 610, 'listed_count': 3, 'favourites_count': 2044,
'statuses_count': 2597, 'created_at': '2016-12-08 17:20:0
3', 'following': False}}
{'tweet': {'id': 1283091065868898306, 'created_at': '2020-07-14 17:28:43', 'text':
'Getting my car fixed is gonna be $300+ an
d getting a tooth pulled for my pup is another $200+. Please share. ♥\U0001f97a',
'source': 'Twitter for iPhone', 'in_reply_t
o_status_id': None, 'in_reply_to_user_id': None, 'in_reply_to_screen_name': None,
'quote_count': 0, 'reply_count': 0, 'retwee
t_count': 0, 'favorite_count': 0, 'entities_hashtags': [], 'entities_urls': [],
'entities_mentions': None, 'original': False,
 'retweet': True, 'quoted_retweet': False, 'lang': 'en'}, 'user': {'id':
1135769816156069888, 'name': 'Cat🎨💿', 'screen_name
': 'SoftArtByCat', 'location': 'HTX', 'followers_count': 1552, 'friends_count':
555, 'listed_count': 10, 'favourites_count':
29368, 'statuses_count': 15771, 'created_at': '2019-06-04 04:46:40', 'following':
False}}
```

Task 5 - Spark streaming (25%)

Description

The code for this part of the assignment is under src/twitter-streaming.py. The classes used for preprocessing the dataset during model training have been utilized for preprocessing the stream of tweets.

```
BASH shell

spark-submit homework/src/twitter-streaming/main.py
```

Output

hdfs dfs -ls output

```
BASH shell

root@s01:~# hdfs dfs -ls output/
Found 4 items
drwxr-xr-x   - root supergroup          0 2020-07-16 20:51
output/one_vs_rest_log_reg.model
drwxr-xr-x   - root supergroup          0 2020-07-16 11:44
output/query_shoes.parquet
drwxr-xr-x   - root supergroup          0 2020-07-21 18:00
output/streamed_predictions.parquet
drwxr-xr-x   - root supergroup          0 2020-07-21 18:00
output/streamed_predictions.txt
```

printSchema() output

```
root
 |-- descr: string (nullable = true)
 |-- prediction: double (nullable = true)
```

Example output of df.show(truncate = False) (in console)

```
+---------------------------------------------------------------------------------
------------------------------------------------------------------------+---------
-+
|descr
|prediction|
+---------------------------------------------------------------------------------
------------------------------------------------------------------------+---------
-+
| aycomedian classic palms shoes in nigeria for sale at online shop join our promo
and buy for as low as n3000 https t co srjitmwubx https t co zuxcz3kung|1.0
|
+---------------------------------------------------------------------------------
```

```
------------------------------------------------------------------------+---------
-+
```

```
+---------------------------------------------------------------------------------
----------------------------------------------------------------------------------
-----------------------+----------+
|descr
|prediction|
+---------------------------------------------------------------------------------
----------------------------------------------------------------------------------
-----------------------+----------+
| it is totally impossible to be well dressed in cheap shoes all items are
available for sale if this gets to your tl kindly retweet my customers might be on
your tl https t co 5ci2us4hth|1.0       |
+---------------------------------------------------------------------------------
----------------------------------------------------------------------------------
-----------------------+----------+
```

Example output of saved .txt file

```
BASH shell

hdfs dfs -cat output/streamed_predictions.txt/part-00000-03f96c3c-8dae-4b16-81b5-
ae6fc55f3e4a-c000.csv
```

```
troy_lake thehoopgenius the jordan s in envius023 s closet look like the kinda
shoes that you build a house in,0.0
i act like everything s okay but i really want more shoes,1.0
i act like everything s okay but i really want more shoes,1.0
good morning donjazzy i know i m not entitled to collect anything from you but
please i need a business loan from you i m already 85 done with my first ever
store th
at s d reason i ve been trying so hard to win your giveaways i ll be selling
unisex clothes and shoes https t co xd6nwddmnm,3.0
this is such a rare condition but what a special ending shared on the todayshow
put yourself in this mama s shoes for even a minute seriously how scary and
stressful
 u0001f9e1 u0001f9e1 u0001f9e1 when ervina and prefina were born https t co
kn25skkn6d,4.0
hey y all my name is samya and i would like to introduce my twitter followers to
sammy s shoetique i have a few shoes on my website and i will also have a few
clothi
ng pieces coming soon i will be moving to the hattiesburg area pretty soon ig
sammysshoetique tag and retweet https t co 9ratlmgdsk,0.0
wangpupy of course idols lip sync not because they cant sing but because of the
exhausting schedule they get everyday imagine sleeping late and then waking up
early
```

```
in the morning just to practice your not on their shoes to say that lip syncing is
an embarrassment,0.0
i love the shoes https t co 7fw3sn1vlv,1.0
guys i m so upset my shoes arrived from ali express and i_ https t co
wcux1bqps6,1.0
i act like everything s okay but i really want more shoes,1.0
i act like everything s okay but i really want more shoes,1.0
mattmackowiak 100x cooler than mattgaetz s clown shoes,2.0
mexi_dutch hampb0ne tedcruz or unless you actually buy quality products my shoes
ain t made in china my electronics are made in taiwan japan germany and so on my
clo
thes are made in india and such and so on and so forth srsly its not as hard as
people think to not buy chinese,3.0
nicki i see them blue pink shoes you ain t slick my dear naw but congrats on yo
bundle of joy,1.0
```